

WHAT IS CLAIMED IS:

1 1. A computer-implemented method of managing bandwidth:
2 receiving packets on an input port;
3 classifying received packets in a classification
4 engine;
5 processing the classified packets in a processing
6 system; and
7 queuing packets in a queuing engine.

1 2. The computer-implemented method of claim 1 wherein
2 the packets comprise network packets.

1 3. The computer-implemented method of claim 2 wherein
2 the network packets comprise traffic types.

1 4. The computer-implement method of claim 3 wherein the
2 traffic types comprise wide area network (WAN) traffic
3 destined for a local area network (LAN).

1 5. The computer-implemented method of claim 3 wherein
2 the traffic types comprise local area network (LAN) traffic
3 destined for a wide area network (WAN).

1 6. The computer-implemented method of claim 1 wherein
2 classifying comprises:
3 generating hash values based on components of the
4 network packets; and

determining corresponding classes for the hash values.

7. The computer-implemented method of claim 6 wherein the components comprise 5-tuples.

8. The computer-implemented method of claim 7 wherein the 5-tuples comprise destination addresses, destination ports, source addresses, source ports and protocol numbers.

9. The computer-implemented method of claim 1 wherein processing system comprises rate shaping packet processing.

10. The computer-implemented method of claim 9 wherein rate-shaping processing comprises:

determining whether class borrowing is enabled for the class assigned to the packet;

determining an advertised window size for a class that has class borrowing disabled by the algorithm:

$$C = B / (n) (D)$$

where C is the capacity of the class, B is the class bandwidth, n is the number of currently active connections and D is an estimate of round trip time of the connection; and

determining an advertised window size for a class that has class borrowing enabled by the algorithm:

$$C = B' / (n) (D)$$

where B' is the maximum of class bandwidth and burst bandwidth.

1 11. The computer-implemented method of claim 1 wherein
2 processing comprises session bandwidth packet processing.

1 12. The computer-implemented method of claim 1 wherein
2 session bandwidth packet processing comprises:

3 generating a new class for the packet class if a
4 packet class specifies a guaranteed minimum bandwidth;

5 assigning the new class the guaranteed minimum
6 bandwidth; and

7 generating a 5-tuple filter for the new class.

1 13. The computer-implemented method of claim 12 wherein
2 the 5-tuple filter comprises a destination address of the
3 packet, a destination port of the packet, a source address of
4 the packet, a source port and a protocol of the packet.

1 14. The computer-implemented method of claim 1 wherein
2 processing comprises admission control packet processing.

1 15. The computer-implemented method of claim 1 wherein
2 admission control packet processing comprises session:

3 receiving a connection;

4 determining a class for the connection;

5 determining whether there is sufficient bandwidth
6 for the class to guarantee a minimum bandwidth;

7 determining an admission directive from the class;

8 and

9 processing the packets in the connection in response
10 to the admission directive.

1 16. The computer-implemented method of claim 15 wherein
2 the admission directive is squeeze.

1 17. The computer-implemented claim of 16 wherein
2 processing comprises reclassifying the packet to a default
3 class.

1 18. The computer-implemented method of claim 15 wherein
2 the admission directive is drop.

1 19. The computer-implemented claim of 18 wherein
2 processing comprises dropping the connection.

1 20. The computer-implemented method of claim 15 wherein
2 the admission directive is deny.

1 21. The computer-implemented claim of 20 wherein
2 processing comprises generating a reset packet.

1 22. The computer-implemented method of claim 1 wherein
2 processing comprises type of service (TOS) packet processing.

1 23. The computer-implemented method of claim 1 wherein
2 TOS packet processing comprises changing TOS values to match
3 underlying application.

1 24. The computer-implemented method of claim 1 wherein
2 processing comprises:

3 session bandwidth packet processing;
4 rate shaping packet processing;
5 admission control packet processing; and
6 TOS packet processing.

1 25. The computer-implemented method of claim 1 wherein
2 queuing comprises placing processed packets in queues
3 according to classes.

1 ~~26.~~ A bandwidth management system comprising:
2 an input port, the input port connected to a
3 classification engine;
4 a processing engine, the processing engine connected
5 to the classification engine; and
6 a queuing engine connected to the processing engine
7 and to an output port.

1 27. The bandwidth management system of claim 26 wherein
2 the processing engine comprises:

3 session bandwidth engine.
4 a rate-shaping engine;
5 an admission control engine; and
6 TOS processing engine.

1 28. The bandwidth management system of claim 26 further
2 comprising a policy manager connected to the processing and
3 queuing engine.

1 29. The bandwidth management system of claim 28 wherein
2 the policy manager is an input device providing parameters.

1 30. The bandwidth management system of claim 29 wherein
2 the parameters comprise a class bandwidth and class priority.

1 31. A computer-implemented method of managing bandwidth
2 comprising:
3 classifying network packets according to traffic
4 types for placement in class queues;
5 generating parent classes for each class;
6 allocating parent bandwidths to the parent classes;
7 assigning a parent priorities to the parent classes;
8 generating sub-parent classes for each parent class;
9 and
10 providing a minimum bandwidth to the sub-parent
11 classes.

1 32. The computer-implemented method of claim 31 wherein
2 the minimum bandwidth is the parent bandwidth.

1 33. The computer-implemented method of claim 31 wherein
2 the sub-parent classes borrow bandwidth from the parent class.

1 34. The computer-implemented method of claim 31 further
2 comprising processing the packets in a connection in response
3 to an admission directive.

1 35. The computer-implemented method of claim 34 wherein
2 the admission directive is squeeze.

1 36. The computer-implemented claim of 35 wherein
2 processing comprises reclassifying the packet to a default
3 class.

1 37. The computer-implemented method of claim 34 wherein
2 the admission directive is drop.

1 38. The computer-implemented claim of 37 wherein
2 processing comprises dropping the connection.

1 39. The computer-implemented method of claim 34 wherein
2 the admission directive is deny.

1 40. The computer-implemented of claim 39 wherein
2 processing comprises generating a reset packet.

1 41. The computer-implemented method of claim 1 further
2 comprising receiving parameters from a policy manager.

1 42. The computer-implemented method of claim 41 wherein
2 the parameters comprise a class bandwidth and a class
3 priority.

1 43. The computer-implemented method of claim 1 further
2 comprising:

3 queuing the processed packets in a queuing engine;

4 and

5 scheduling the queued packets on an output port.

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